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Milk-Production Value of a Concentrate Mixture Composed Entirely of Southern Agricultural Byproducts [1] [2]

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United States Department of Agriculture, Bureau of Dairy Industry, in cooperation with the North Carolina State Department of Agriculture and the Agricultural Experiment Station of the North Carolina State College of Agriculture

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INTRODUCTION

Dehydrated sweetpotatoes and dried citrus pulp are being produced in considerable quantities in the South. Still larger quantities could be produced, and no doubt would be if their usefulness as feed for livestock were better established.

Research workers have investigated the value of these materials as components of a dairy ration made up largely of grains and other concentrates, but practically no research has been conducted with rations made up entirely of agricultural products or byproducts that are produced only in the South.

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[2] The experimental work reported in this publication was conducted with funds made available through the Agricultural Research and Marketing Act of 1946.

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Recognizing the economic advantages of extending the use of southern-produced byproducts, and that dairymen might save substantial quantities of grain if they could make greater use of these byproducts, the Bureau of Dairy Industry began in the spring of 1948 to explore the possibilities of preparing suitable concentrate mixtures entirely from southern byproduct feeds, without including grains.

Two feeding experiments have been completed, in which a concentrate mixture consisting of dehydrated sweetpotatoes, dried citrus pulp, peanut meal, and cottonseed meal—all southern-produced feeds—was compared with a standard grain mixture. One experiment was conducted at the Dairy Field Experiment Station, Lewisburg, Tenn., and the other at the Coastal Plains Station, Willard, N. C. The experiment at the latter station was conducted in cooperation with the North Carolina State Department of Agriculture and the Agricultural Experiment Station of the North Carolina State College of Agriculture. This publication gives the results of both experiments.

EXPERIMENTAL PROCEDURES

Dehydrated sweetpotatoes, dried citrus pulp, and peanut meal were purchased in North Carolina for use both at the Lewisburg station and at the Willard station. The dehydrated sweetpotatoes probably originated in North Carolina; but the peanut meal was manufactured in Alabama, by the solvent-extraction process. The dried citrus pulp originated in Florida and was composed of the ground peel and pulp from oranges and grapefruit.

The same experimental concentrate mixture was fed at each station, in comparison with the same standard grain mixture (check). Two well-balanced groups of Jersey cows were used at each station—5 cows in each group at the Lewisburg station and 4 in each group at the Willard station, or 18 cows in all. The cows were fed according to the double reversal method, for three 30-day periods. The first 10-day period and the 10-day periods between reversals were considered as change periods to enable the cows to become accustomed to the ration. Consequently, the data used in calculating the results are for only 20 days of each 30-day feeding period.

The experimental concentrate mixture consisted of 375 pounds of dehydrated sweetpotatoes, 375 pounds of dried citrus pulp, 125 pounds of peanut meal, and 125 pounds of cottonseed meal.

The standard grain mixture (check) consisted of 400 pounds of corn meal, 300 pounds of ground oats, 200 pounds of wheat bran, and 100 pounds of cottonseed meal.

Calculations based on the average composition of all feeds, as given by Morrison,[4] indicated that the experimental mixture would contain 12.1 percent of digestible protein and 73.8 percent of total digestible nutrients; and that the grain mixture (check) would contain 11.3 percent of protein and 76.7 percent of total digestible nutrients.

Both concentrate mixtures were fed daily at the rate of 1 pound for each 3½ pounds of 4-percent fat-corrected milk produced at Lewisburg.

[4] Morrison, Frank B. feeds and feeding, a handbook for the student and stockman. Ed. 21, unabridged, 1207 pp., illus. Ithaca, N. Y. 1948.

At Willard both mixtures were fed at the rate of 1 to 3 at the start of the experiment, and reduced 2 percent every 10 days thereafter.

At Lewisburg, where no corn silage was available, the roughage part of both rations consisted of good quality alfalfa hay. The daily amount of hay was limited to 1.6 pounds per 100 pounds of body weight, to insure full consumption of the concentrate mixtures.

At Willard, the roughage consisted of corn silage and alfalfa hay. The silage was fed daily at the rate of 3 pounds per 100 pounds of body weight; and the alfalfa hay was limited to 1 pound daily per 100 pounds of body weight.

Records of roughage consumption by individual cows were obtained at Willard, but not at Lewisburg because individual mangers were not available and the hay was fed by groups.

At Lewisburg, the cows were housed in a pen barn (five cows to a pen) and moved to a separate barn for milking. At Willard the cows were housed and milked in a conventional stanchion barn. All cows were milked by machine, twice a day.

The usual routine records were kept. The milk produced by each cow was weighed daily and tested for butterfat content 1 day in each 10-day period. The cows were weighed at the beginning of the experiment and at the beginning of each 10-day period thereafter. The concentrate mixtures and their separate ingredients were sampled and chemically analyzed, as were also the alfalfa hay and corn silage.

Results at the Lewisburg Station

Table 1 shows the order in which the two rations were fed to each group of cows, and gives the average feed consumption and milk production per cow for each 20-day period.

Averaging the results for the two 20-day periods when the five cows in group A were on the experimental ration, and comparing the average with the results for the one 20-day period when they were on the check ration, shows that the group A cows produced 96 percent as much 4-percent fat-corrected milk on the experimental ration as they produced on the check ration.

The group A cows consumed about the same amount of hay on both rations, but somewhat more grain (24 pounds) on the check ration. They lost weight in all three 20-day periods; but the greatest loss (60 pounds) was for the second 20-day period, when they were on the check ration. These losses probably are not significant.

The rations were fed in the reverse order to the cows in group B. Averaging the results for the two 20-day periods on the check ration, and comparing the average with the results for the one 20-day period on the experimental ration, shows that these cows produced the same amount of 4-percent fat-corrected milk on each ration. They consumed about the same amount of feed on each ration, but lost weight on the experimental ration and gained weight during both periods on the check ration.

Averaging the results for both groups of cows on each ration shows that the differences in milk production, feed consumption, and loss of body weight were too small to be significant (table 1).

TABLE 1.—*Average body weight, feed consumption, and milk production per cow for each 20-day period, in the experiment at Lewisburg, Tenn.*

GROUP A (5 COWS)

Period and ration fed	Average body weight per cow		Average feed consumption per cow		Average production per cow			
	Initial	Final	Hay	Grain	Milk	Butterfat		4-percent fat-corrected milk
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
First 20-day period (experimental ration)	852	845	270	148	433	4.83	20.9	487
Second 20-day period (check ration)	851	791	268	148	382	4.83	18.5	430
Third 20-day period (experimental ration)	840	837	264	99	306	4.64	14.2	336
Average of first and third periods (experimental ration)	846	841	267	124	370	4.74	17.6	412

GROUP B (5 COWS)

First 20-day period (check ration)	889	894	284	143	423	4.81	20.4	475
Second 20-day period (experimental ration)	884	850	280	120	363	4.69	17.0	400
Third 20-day period (check ration)	866	883	275	97	297	4.62	13.7	325
Average of first and third periods (check ration)	878	889	280	120	360	4.72	17.1	400
Average of both groups: [1]								
Experimental ration		[2] 19.5	274	122	367	4.72	17.3	406
Check ration		[2] 24.5	274	134	371	4.78	17.8	415
5 percent least significant difference					8.9	.41	.84	14.9

[1] Average of periods 1 and 3 of one group plus period 2 of the other group, divided by 2.
[2] Loss.

Table 2 shows the chemical composition of the various feeds used in these experiments, together with the estimated amount of digestible protein and total digestible nutrients. Table 3 shows the amount of total digestible nutrients required by the two groups of cows at Lewisburg for maintenance and milk production, the amount of nutrients consumed from hay and the concentrate mixtures, and the amount of 4-percent fat-corrected milk produced per 100 pounds of nutrients consumed.

In all 20-day periods, both groups failed to consume sufficient nutrients to meet the calculated requirements. The cows consumed 86 percent of their requirements when they were fed the experimental ration and 88 percent when they were fed the check ration. This was probably the result of limiting hay consumption to 1.6 pounds per

100 pounds of body weight and the probable reason for an apparent loss in body weight. On the basis of the amount of 4-percent fat-corrected milk produced per 100 pounds of nutrients consumed by the cows in both groups, the experimental ration was 2 percent more efficient than the check ration.

TABLE 2.—*Chemical composition and estimated digestible protein and total digestible nutrient content of feeds used in the Lewisburg and Willard experiments*

Feed, and station where used	Dry matter	Total composition					Calculated [1]	
		Ash	Ether extract	Crude protein	Nitrogen-free extract	Crude fiber	Digestible protein	Total digestible nutrients
Corn meal:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Lewisburg	83.88	1.34	3.69	7.63	69.23	1.99	5.88	78.9
Willard	86.58	1.17	3.68	8.63	71.12	1.98	6.65	81.4
Oats:								
Lewisburg	86.10	2.94	6.12	11.56	56.88	8.60	9.02	70.48
Willard [2]								
Cottonseed meal:								
Lewisburg	90.10	5.17	6.13	39.79	27.48	11.53	31.83	70.39
Willard	91.10	5.74	6.37	33.50	29.07	16.42	26.80	69.20
Citrus pulp:								
Lewisburg	89.82	6.70	7.57	6.81	51.59	17.15	[3] 3.54	[3] 76.29
Willard	95.15	7.77	7.86	6.97	55.01	17.55	[3] 3.62	[3] 80.34
Peanut meal:								
Lewisburg	92.96	4.65	6.17	44.15	31.65	6.34	40.18	83.83
Willard	90.24	8.69	2.45	41.06	23.91	14.13	37.37	70.49
Dehydrated sweetpotatoes:								
Lewisburg	85.59	3.87	.86	4.01	73.07	3.78	.60	70.34
Willard [4]								
Wheat bran:								
Lewisburg	86.77	6.06	3.92	13.63	53.28	9.88	11.04	63.69
Willard	90.00	6.52	4.42	15.31	53.50	10.23	12.40	66.33
Experimental mixture:								
Lewisburg	89.14	6.91	4.71	15.00	52.23	10.30	[5] 10.56	[5] 74.27
Willard	91.96	8.07	4.21	13.06	54.07	12.55	[5] 9.60	[5] 73.97
Check mixture:								
Lewisburg	85.09	5.17	3.85	13.86	56.06	6.15	[5] 10.45	[5] 72.48
Willard	89.17	3.45	5.09	11.31	59.63	9.69	[5] 10.53	[5] 73.89
Alfalfa hay:								
Lewisburg	89.57	5.38	2.11	13.82	37.94	30.31	9.81	51.23
Willard [2]								
Corn silage:								
Lewisburg [6]								
Willard	23.90	1.13	.59	1.85	14.18	6.09	.98	15.76

[1] The digestion coefficients used in making these calculations, unless otherwise noted, are those given in Morrison's Feeds and Feeding, twenty-first edition.

[2] Not analyzed at Willard.

[3] The digestion coefficient used in making this calculation was an average of those for dried orange pulp and dried grapefruit pulp.

[4] For reasons unexplained, the sample of dehydrated sweetpotatoes at Willard increased in weight in the drying oven. Analysis of the Lewisburg sample from the same lot is used here.

[5] Based on calculations for the individual ingredients in the mixture.

[6] Silage was not fed at Lewisburg.

TABLE 3.—*Average amount of nutrients consumed and required per cow, and the average amount of milk produced per 100 pounds of total digestible nutrients consumed per cow, by 20-day periods on each ration, in the experiment at the Lewisburg station*

GROUP A (5 COWS)

Period and ration fed	Nutrients consumed in—			Nutrients required for—			4-percent fat-corrected milk produced per 100 pounds of nutrients consumed
	Hay	Grain	Total	Maintenance	Production	Total	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First 20-day period (experimental ration)	138.3	109.9	248.2	134.6	157.7	292.3	196.2
Second 20-day period (check ration)	137.3	107.3	244.6	130.2	139.3	269.5	175.8
Third 20-day period (experimental ration)	135.3	73.5	208.8	133.0	108.8	241.8	160.9
Average of first and third periods (experimental ration)	136.8	91.7	228.5	133.8	133.3	267.1	178.6

GROUP B (5 COWS)

First 20-day period (check ration)	145.5	103.6	249.1	141.4	153.8	295.2	190.7
Second 20-day period (experimental ration)	143.4	89.1	232.5	137.5	129.7	267.2	172.0
Third 20-day period (check ration)	140.9	70.3	211.2	138.7	105.3	244.0	153.9
Average of first and third periods (check ration)	143.2	87.0	230.2	140.1	129.6	269.6	172.3
Average of both groups: [1]							
Experimental ration	140.1	90.4	230.5	135.7	131.5	267.2	175.3
Check ration	140.3	97.2	237.4	135.2	134.5	269.6	174.1

[1] Average of periods 1 and 3 of one group plus period 2 of other group, divided by 2.

From these results, it is concluded that there is little choice between the two rations. Some difficulty was experienced in getting the cows to consume all of the experimental concentrate mixture, especially during the preliminary 10-day period at the start of the experiment. This would indicate that either the dehydrated sweetpotatoes or the dried citrus pulp, or both, were somewhat lacking in palatability.

RESULTS AT THE WILLARD STATION

Table 4 shows the order in which the two rations were fed to each group of cows, and gives the average weight, feed consumption, and milk production per cow for each 20-day period.

The four cows in group A were started on the experimental ration. Their milk production (4-percent fat-corrected basis) averaged about the same for the two 20-day periods on the experimental ration as for the one period on the check ration. The average feed consumption was also about the same on both rations, but the average body weight was somewhat heavier while the cows were on the experimental ration.

The four cows in group B were started on the check ration. Their average milk production for the two 20-day periods on the check ration was 34 pounds less than for the one period on the experimental ration, but they made a rather steady increase in weight—from an average of 913 pounds in the first 20-day period to an average of 955 pounds in the third period.

Averaging the results for both groups of cows on each ration shows that they produced an average of 510 pounds of 4-percent fat-corrected milk on the experimental ration, which was 3.5 percent more (18.0 pounds) than they produced on the check ration. This difference was statistically significant at the 5 percent level.

TABLE 4.—*Average body weight, feed consumption, and milk production per cow for each 20-day period, in the experiment at Willard, N. C.*

Period and ration fed	Average body weight per cow		Average feed consumption per cow			Average production per cow			
	Initial	Final	Hay	Silage	Grain	Milk	Butterfat		4-percent fat-corrected milk
GROUP A (4 COWS)									
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
First 20-day period (experimental ration)	916	960	226	542	186	475	5.85	27.8	607
Second 20-day period (check ration)	947	944	190	548	174	446	5.40	24.1	540
Third 20-day period (experimental ration)	950	978	188	550	161	396	5.35	21.2	476
Average of first and third periods (experimental ration)	933	969	207	546	174	436	5.60	24.5	542
GROUP B (4 COWS)									
First 20-day period (check ration)	895	930	224	540	161	399	5.70	22.7	500
Second 20-day period (experimental ration)	932	932	187	545	149	374	5.81	21.9	478
Third 20-day period (check ration)	940	969	187	558	137	315	5.52	17.4	387
Average of first and third periods (check ration)	918	950	206	549	149	357	5.61	20.1	444
Average of both groups:[1]									
Experimental ration		[2] +18.0	197	546	162	405	5.71	23.2	510
Check ration		[2] +14.5	198	549	162	402	5.51	22.1	492
5-percent least significant difference						10.6	.31	1.05	17.5

[1] Average of periods 1 and 3 of one group plus period 2 of other group, divided by 2.

[2] Gain.

The chemical composition of the various feeds fed at the Willard station, together with the estimated amount of digestible protein and total digestible nutrients, is shown in table 2. Table 5 shows the amount of total digestible nutrients required by the two groups of cows for maintenance and milk production, the amount of nutrients consumed from the roughage and grain, and the amount of 4-percent fat-corrected milk produced per 100 pounds of nutrients consumed.

TABLE 5.—*Average amount of nutrients consumed and required per cow, and the average amount of milk produced per 100 pounds of total digestible nutrients consumed per cow, by 20-day periods on each ration, in the experiment at the Willard station*

GROUP A (4 COWS)

Period and ration fed	Nutrients consumed in—				Nutrients required for—			4-percent fat-corrected milk produced per 100 pounds of nutrients consumed
	Hay	Silage	Grain	Total	Maintenance	Production	Total	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First 20-day period (experimental ration)	115.8	85.4	137.6	338.8	148.8	196.5	345.3	179.1
Second 20-day period (check ration)	97.3	86.4	128.6	312.3	150.0	174.9	324.8	172.9
Third 20-day period (experimental ration)	96.3	86.7	119.1	302.1	152.9	154.5	307.3	157.6
Average of first and third periods (experimental ration)	106.1	86.1	128.4	320.5	150.9	175.5	326.3	168.4

GROUP B (4 COWS)

First 20-day period (check ration)	114.8	85.1	119.0	318.9	144.7	162.2	306.9	156.8
Second 20-day period (experimental ration)	95.8	85.9	110.2	291.9	147.8	154.6	302.5	163.8
Third 20-day period (check ration)	95.8	87.9	101.2	284.9	151.4	125.4	276.8	135.8
Average of first and third periods (check ration)	105.3	86.5	110.1	301.9	148.1	143.8	291.9	146.3
Average of both groups: [1]								
Experimental ration	101.0	86.0	119.3	306.2	149.4	165.1	314.4	166.1
Check ration	101.3	86.5	119.4	307.1	149.1	159.4	308.4	159.6

[1] Average of periods 1 and 3 of one group plus period 2 of other group, divided by 2.

The consumption of nutrients by both groups just about equaled their requirements. For the three periods they were on the experimental ration, the cows consumed 97 percent of their requirements as compared with 99.6 percent when they were fed the check ration. For the most part, they also gained weight in all periods.

On the basis of the amount of 4-percent fat-corrected milk produced per 100 pounds of total digestible nutrients consumed by the cows in both groups, the experimental ration was 4.6 percent more efficient than the check ration.

The cows in this experiment, unlike the cows at the Lewisburg station, ate the experimental ration readily and there was no evidence of unpalatability.

Combined Results of the Two Experiments

In view of the fact that both experiments were carried out so nearly alike, it is of interest to combine the results of the two experiments. The average production of the 18 cows when they were on the experimental ration was 22.8 pounds of 4-percent fat-corrected milk per cow per day, and the average when they were on the check ration was 22.7 pounds.

COMPARATIVE COSTS

The cost of the feeds used in these experiments, at the time of their purchase at Willard, N. C., was as follows:

Feeds	*Cost per 100 pounds*
Citrus pulp	$2.76
Dehydrated sweetpotatoes	3.98
Peanut meal	5.15
Cottonseed meal	4.64
Corn	4.70
Oats	4.82
Wheat bran	4.63
	Cost per ton
Alfalfa hay	$57.00
Corn silage (estimated)	8.00

On the basis of the above prices, the cost of the experimental mixture was $75.04 per ton, or $5.06 per 100 pounds of total digestible nutrients. The cost of the check mixture was $94.32 per ton, or $6.45 per 100 pounds of total digestible nutrients. On the nutrient basis, the check mixture cost about 27 percent more than the experimental mixture.

Total feed cost (including roughage) per 100 pounds of 4-percent fat-corrected milk was $2.72 for the experimental ration and $3.15 for the check ration at Willard; and it was $3.05 for the experimental ration and $3.40 for the check ration at Lewisburg. Thus there was a saving on the experimental ration of 43 cents per 100 pounds of milk at Willard and 35 cents per 100 pounds of milk at Lewisburg.

SUMMARY AND CONCLUSIONS

Eighteen cows, divided into two groups, were fed an experimental ration and a standard grain ration (check) according to the double reversal plan for three 20-day periods. The concentrate mixture in the experimental ration was made up of 375 pounds each of dried citrus pulp and dehydrated sweetpotatoes and 125 pounds each of peanut meal and cottonseed meal. No grains were included in the

mixture, and all ingredients of the ration were produced in the southern area of the United States. The standard grain mixture in the check ration was composed of 400 pounds of corn meal, 300 pounds of ground oats, 200 pounds of wheat bran, and 100 pounds of cottonseed meal.

The cows produced approximately the same amount of milk (4-percent fat-corrected basis) on both rations.

The check ration cost $19.28 more per ton than the experimental ration, or $1.39 more per 100 pounds of total digestible nutrients.

The experimental ration, which was composed entirely of southern-produced agricultural products or byproducts, proved to be at least equal to the check ration, which included 70 percent of grains. The results emphasize the desirability of increasing the production of these agricultural byproducts and also their use in concentrate mixtures for dairy cattle.

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